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PARENTS' PERCEPTION TOWARDS THE ADOPTION OF MOBILE APPLICATION FOR MONITORING THEIR CHILDREN'S OBESITY STATUS

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ABSTRACT
Obesity among children around the world has now reached an alarming level. Obesity affects one out of every ten children or teenagers all over the world. Parents should be the one responsible for their children well-being. With the advent of mobile technology, various mobile app have been developed to help people to manage their daily lives. This paper discusses on the development and evaluation of the Body Mass Index (BMI) Percentile Monitor, a mobile app for monitoring children's obesity status by parents. The results of the evaluation indicated that the parents highly rated the application in terms of usefulness, ease of use, hedonic motivation, outcome/future Use and satisfaction.

Key words: Mobile Technology · Mobile Appilication · Obesity · Body Mass Index ·

1. INTRODUCTION

In recent years, childhood obesity has been one of the issues that are of great concern in most developing countries. According to Segel (2011), the World Health Organization (WHO) declared that overweight or obesity affects one out of every ten children or teenagers all over the world. Whilst in 2012, an estimated 44 million (6.7%) of children under 5 years of age were overweight or obese (World Health Organization, 2014). Child obesity causes high risk due to its relation to diseases such as Hypertension, Dyslipidemia, Metabolic Syndrome and Type 2 Diabetes Mellitus (Gupta et al, 2013; Herouvi et al, 2013). Throughout the world, child obesity has rapidly becomes one of the prominent health challenges and spreads widely over the years (O'Dea and Eriksen, 2010). In 2010, 43 million children were estimated to be overweight and obese worldwide, with 35 million in developing countries (De Onis et al, 2010). In the United States, during the period of 2010 to 2011, the prevalence of child obesity has reached greater than 20%. The prevalence of child obesity among children from lower-income families rose from 12.7% in 1999 to 14.4% in 2010 (Levi et al, 2014). On the other hand, there was about one-third (32 percent) of children aged from 2 to 19 are overweight, and 18 percent are obese in the USA (World Health Organization, 2014). Meanwhile, child obesity for low-income aged between 6-18 years in eight European cities has increased (Evans et al, 2012).

In Malaysia, child obesity has also increased where data showed that as much as 30 percent of primary school children and 15 percent of toddlers and pre-school children are obese or overweight (HEALTH TODAY, 2013). In 2008, a study by Universiti Kebangsaan Malaysia (UKM) on a sample of 9,375 primary school children found that more than 25 out of 100 children were classified as either overweight or obese (Nutrition Month Malaysia, 2013). Additionally, the problem is getting worse where obesity among Malaysian children is highest in Southeast Asia and ranked sixth in Asia countries (Soliano, 2013). Problems that arise due to obesity from childhood into adulthood can be seen through the increase of cardiovascular diseases including Hypertension, Dyslipidemia, Metabolic Syndrome and Type 2 Diabetes Mellitus and Coronary Artery disease later in life (Gupta et al, 2013; Herouvi et al, 2013). In tackling this problem, the effort has to start early when the children are still small. According to (Singh et al, 2008), childhood obesity is an independent risk factor for adult obesity. Parents' involvement is the most influential treatment of childhood obesity (Oude Luttikhuis et. al, 2009). Parents' involvement in monitoring their children's BMI is important to address the obesity epidemic (Anderson and Whitaker, 2010; Ward et. al, 2011). Thus, family's realization of excess weight and its related health hazards to their child is likely to be the significant step towards an effective intervention.

2. BACKGROUND

2.1 Parents Intervention in reducing Child Obesity

Parents play an important role in the issue of child obesity. Research supports parental involvement in interventions to prevent and reduce childhood overweight and obesity because parents play such an important role in a child's life (McGarvey et al, 2004; Slawta et al, 2008). Parents play a major role in the socialization of eating behaviors in young children (Faith et al, 2004; Clark et al, 2007). It is important for parents to know how to maintain healthy food, healthy life style and physical activity habits for their children. During the preschool years, parents are usually the primary determinants of the types and amounts of food their children eat (Ventura and Birch, 2008). Parents should be primarily responsible for food procurement, choices and meal preparation. Parents can be a strong positive influence on their children (Adamo and Brett, 2014). Family involvement is the key to an effective treatment of childhood obesity (Anderson and Whitaker, 2010), therefore parents' recognition of excess weight and its associated health risks in their children are likely to be important steps towards successful intervention. Parents

who perceive their child's weight to be a health problem are more likely to be prepared to make behavior changes to help with weight management (Rhee et al, 2005). However, more than 60% of parents fail to recognize their child is overweight (Rietmeijer-Mentink et al, 2013). Parental involvements in interventions targeting childhood obesity can help to prevent unhealthy increase in children's BMI (Story and friends, 2003). Sufficient evidence supports the inclusion of parents in interventions to prevent and treat childhood obesity; however, there is no consensus yet on which type of intervention is the most effective (Maynard et al, 2009). Currently, there is no structured framework for childhood obesity prevention interventions involving parents (Mast and friends, 2002). Parents have a significant role to play and successful intervention effort is supposed to come directly from the parents from earlier stage to support healthy life inside and outside the home. Given that obesity early in life has effects on health and economic outcomes into adulthood (Cawley, 2010).

2.2 Body-Mass-Index (BMI)

BMI is the most common method that has been used to assess the level of obesity since it is easy to use, relatively cheap and reliable (Lob-Corzilius, 2007). It is considered the standard method for assessing the weight status of children in terms of underweight, healthy weight, overweight and obese (Dennison and Boyer, 2004). BMI provides an excellent indicator of overweight and obesity that is sufficient for most clinical and surveillance purposes. However, it is not a diagnostic tool. The calculations for BMI are as follows:

$$BMI=\text{Weight (kilograms)}/[\text{Height (meters)}]^2$$
$$BMI=(\text{Weight (lb)}/[\text{Height (in)}]^2) \times 703$$

BMI for adults are different from BMI for children. The age for adult is from 20 years and above and the calculation of adult's BMI does not depend on gender or age. Adults are considered overweight if the BMI readings are 25 to 30 and obese if the readings are greater than 30. Meanwhile, for healthy weight the BMI readings are 18.4 to 25, and underweight if the readings are less than 18.5 (Wang and Wang, 2002).

2.3 BMI Percentile

In calculating the BMI for children, the age must be from 2 to 20 years, while there is no BMI calculation for children under 2 years old. The BMI for children could be determined using the 2000 age and gender specific growth charts from the Centers for Disease Control and Prevention (CDC) (Kellomaki et al, 2000). The BMI-for-age percentiles growth chart for boys is shown in Figure 1 and for girls is shown in Figure 2. Percentile is the most frequently used indicator to evaluate size and growth patterns of individual children in the United States (Sawyer, 2011). Children is considered overweight if the BMI is equal or above the 85th percentile and under the 95th percentile and obese if the BMI is equal or above the 95th percentile. Children's BMI below the 5th percentile is considered underweight, while above the 5th percentile and below the 85th percentile is considered healthy weight (Office of the Surgeon General (US), Office of Disease Prevention and Health Promotion, Centers for Disease Control and Prevention and National Institutes of Health, 2001).

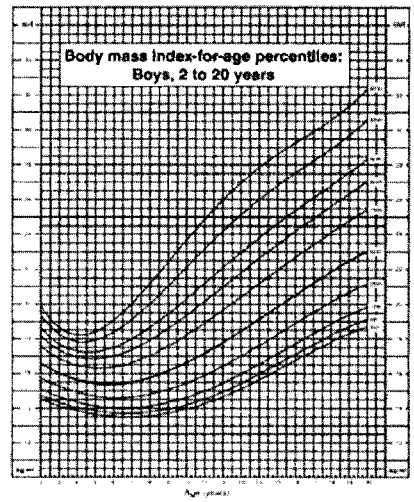

Figure-1. BMI-for-age growth chart for boys.

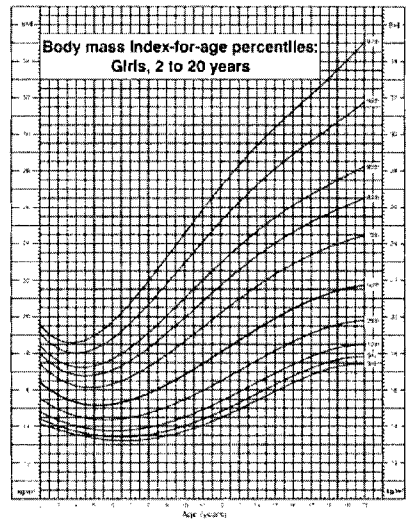

Figure-2. BMI-for-age growth chart for boys

2.4 Mobile Technology

Tiainen, Wigelius and Lonnqvist (Kellomaki et al, 2000) stated that Mobile technology entered the main stream in 2002 when the global number of mobile networks exceeded the number of fixed lines and in January 2007, the number of mobiles doubled the number of fixed lines with 2.6 billion. They added that eighty percent of the world's population are exposed and live in the vicinity of a mobile signal. In developed world, mobile technology continues to exist among other ICTs, but in developing countries, mobile may be the only technology people can access and afford (Teng and Helps, 2010). Nowadays, Smartphone allows users not just for phone call, SMS or e-mail, but a plethora of applications. Smartphone combines features of cell phone and Personal Digital Assistant (PDA) (Aram et al, 2008).

Smartphone has powerful capabilities built on mobile computing and available on various platforms which include Android, iOS, Symbian, Windows Phone and etc.

Mobile technology such as Smartphone enables a new generation of users and business applications (Teng and Helps, 2010). Mobile applications are developed to assist personal mobile phone, personal digital or enterprise digital applications. They can be pre-installed into the mobile phone from the firm or downloaded by users from the applications website (Tahnoon Al Ali et al, 2008). These applications are developed by using many programming languages like HTML, JavaScript, J2ME and etc. Smartphone uses open source operating system such as Android, Windows mobile and iOS. Android has been the most popular mobile platform in the world (Mullen, 2011). According to a survey, majority of people use a mobile phone worldwide and more than half are Asia-Pacific region (3.6 billion out of 7 billion total subscriptions) (ICT, "Facts and Figures," Switzerland, 2014). Meanwhile, mobile applications in the medical field has become also increasing in availability and popularity (Patrick et al, 2008). For example, the mobile health apps include interventions that help people quit smoking (Abroms, 2012) or weight Control (Lopes et al, 2011). Additionally, many mobile apps have been merged into the behavioral healthcare sector as a way to monitor disease such as monitoring the children by school nurses in the United States through collecting and storing data locally, instead of the traditional ways and sent it at a later time to a central database in case of availability of the Internet (Luxton et al, 2011).

2.5 Android Platform

Android is a Linux-based platform developed by using Java programming language and has been introduced by Google in 2007 (Agarwal and Bilokhatniuk, 2012). It is an Open Source Smartphone operating system, middleware, user interface and application software (Wu et al, 2010). In addition, Android platform supports a wide range of audios, images, videos and a lot of other features. Android provides a compatible platform for the proposed prototype of this study. Android applications are developed by using Java and XML languages in order to be exported as the executable file (APK file). Other features of Android include accelerated 3D graphics engine (based on hardware support), database support powered by SQLite and an integrated web browser (DiMarzio, 2008). Moreover, Android platform takes the first place in the 2012 US Smartphone's market with a share of 48.6% as shown in Figure 3 (Chen et al, 2011).

3. APPLICATION DEVELOPMENT

This section discusses the development of the BMI Percentile Monitor app and it involves four stages which include requirements planning, user design, construction and implementation.

3.1 Requirements Planning

In this stage, all the requirements for the development of the BMI Percentile Monitor app were listed based on the following steps. Firstly, all information on body-mass-index and the required charts in determining children obesity status were gathered. Secondly, images to be used in the application were collected, resized to suit mobile phone screen and saved as PNG format. Thirdly, audio files for advice and information were recorded at 128 kbps bit rate and saved as MP3 format.

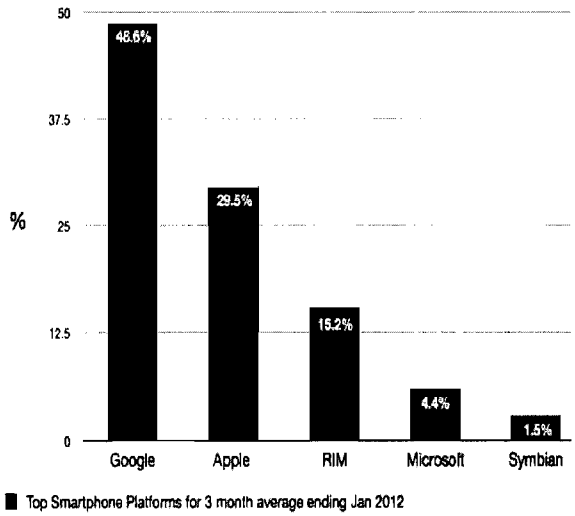

Figure-3. Smartphone platform market share in the US

3.2 User Design

Figure 4 shows the Activity diagram that has been designed for the BMI Percentile Monitor app where it illustrates the sequence of events by the user. Based on this activity diagram, the user will be able to complete all the necessary processes such as launching the application, choosing the language between English or Malay and so on easily.

3.3 Construction

This stage describes the construction of the BMI Percentile Monitor app which is based on the prototyping approach (Laudon and Laudon, 2012). This approach includes three steps developing initial prototype, using prototype and revising and enhancing prototype as shown in Figure 5. The prototype of the application is produced after the completion of this cycle. Finally, after all the steps have been completed, the app is produced in the form of executable file (APK file). The BMI Percentile Monitor app was developed using the standard design principle which contains a rich set of application interfaces. The graphical user interfaces (GUI) in Android mobile applications are significantly important during the development of the application. It provides user with options such as a Data Entry, Data Monitoring, Data Update, Save or Delete Data, Data Monitoring etc which are discussed below.

3.3.1 Splash screen and Main Menu

A splash screen is the background image that shows the application name and logo when the application is running. The screen will be displayed only for a few seconds and then disappeared automatically when the application's main menu appeared, that consists of two buttons; the first one for English language and the second

for Malay language. The application allows the user to select one of the two languages. Figure 6 shows the splash screen and the Main Menu.

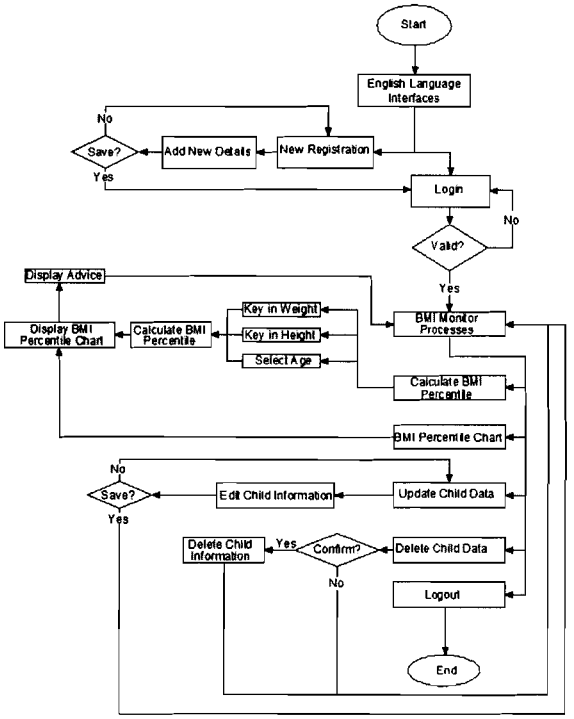

Figure-4. Activity diagram for BMI Percentile Monitor

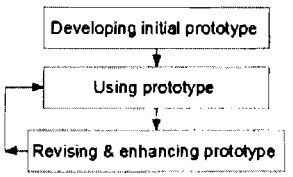

Figure-5. Prototyping Approach

3.3.2 Login

This screen will appear after clicking on the English language button. It is the third screen of the BMI Percentile Monitor application that consist of one text box to insert the ID for user after the registration process and four buttons; Login, New Registration, Back and About. The user must pre-register in order to login. The new registration button enables the user to insert his/her new data. Back button enables the user to return back to the previous screen. The last button is About which gives more information about the application. On the other hand this same process occurs when using the application in Malay Language. Figure 7 shows the Login for English and Malay Languages.

3.3.3 Registration

This screen will appear after clicking on the New Registration button. It is the fourth screen of the BMI Percentile Monitor app that contains user details which include; User ID, Name, Sex, Child, Address and Email. All the information will be stored in a database in the mobile device. The Back button allows the user to return to the previous screen. Figure 8 shows the registration for English and Malay Languages.

Figure-6. Splash screen and The Main Menu

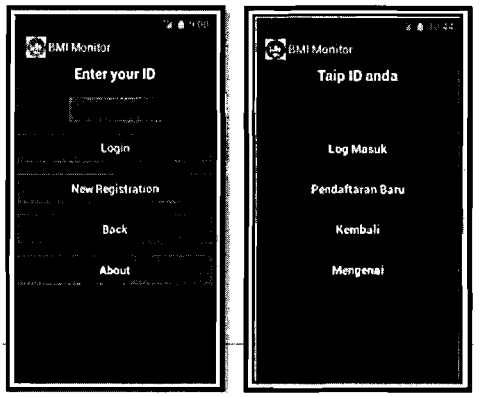

Figure-7. Login for English and Malay Language

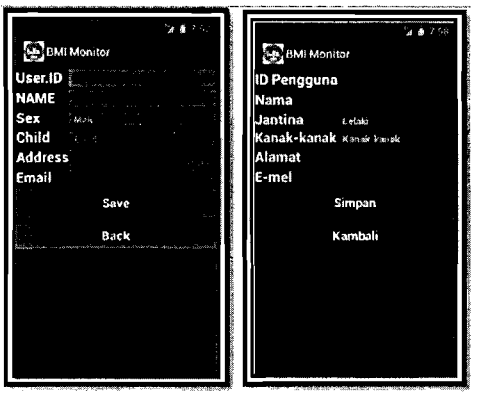

Figure-8. Registration for English and Malay Languages.

3.3.4 The BMI Percentile Monitor Processes

This is the most important screen which will appear after pressing the Login button provided that the user

has prior registration. It is the fifth screen of the BMI Percentile Monitor app which contains many of the processes which include; Calculate BMI Percentile, BMI Percentile Chart, Update Your Data, Delete Your Data, Main Menu, Your Data and Logout. Figure 9 shows the BMI Percentile Monitor processes for the English and Malay Languages.

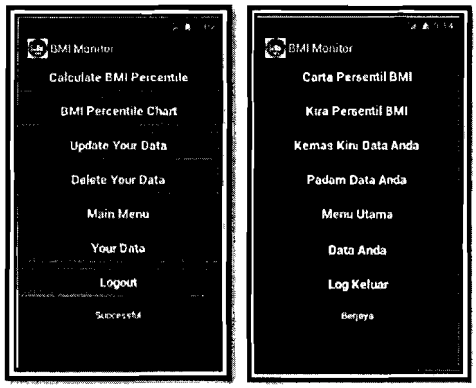

Figure-9. The BMI Percentile Monitor Processes for English and Malay Languages.

3.3.5 Calculate BMI Percentile

This is the sixth screen of the BMI Percentile Monitor app which will appear after pressing the Calculate BMI Percentile button. It allows the user to calculate BMI percentile which requires the user to input the weight in kilograms and the height in centimeters and select the age in months. The BMI Percentile will be stored automatically for each entry in the user's database where user can view this data. The calculated BMI Percentile will be displayed as BMI Percentile Chart. Figure 10 shows the screenshots for BMI Percentile calculation for English and Malay Languages.

Figure-10. The screenshots for BMI Percentile calculation for English and Malay Languages

3.3.6 BMI Percentile Chart

There are two ways of displaying this screen (seventh screen); firstly, by pressing the BMI Percentile Chart button and secondly, the screen will be displayed immediately after the BMI Percentile calculation. It enables the user to see the weight category status which include; underweight, healthy weight, overweight, and obese. The weight category status appears as bar charts with four different colors whereby red represents obese, orange represents overweight, yellow represents underweight, and green represents healthy weight. In addition, the screen displays advices related to the particular weight category status whenever the user touch (click) the bar chart. Figure 11 shows the BMI Percentile Chart for English and Malay Languages.

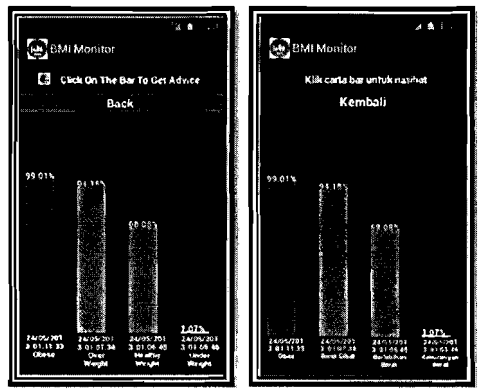

Figure-11. BMI Percentile Chart for English and Malay Languages

3.4 Implementation

This stage is also known as the deployment phase. The APK file produced from the previous stage was installed to the users' Android mobile phones. During the test, all recommendations provided by parents were noted and will be used implemented in the future versions of the app. Some of the recommendations include develops the application in other languages besides English and Malay, sending part of the data to child obesity specialist and BMI Percentile Monitor specific for adults.

4. EVALUATION

The evaluation comprised of heuristic and user evaluations.

4.1 Heuristic Evaluation

Heuristic evaluation was conducted to determine the robustness of the BMI Percentile Monitor app user interfaces and functionalities. The rationale was to detect fault in the app before presenting it to the end users and also to ensure the validity of the app's contents. The experts involved were categorized into two groups; content and user interface (UI) experts. Two medical doctors who have knowledge and experience related to child obesity were required to validate the contents of the app while two lecturers who have knowledge and experience related to the design of user interfaces were required to validate the UIs. Feedbacks and recommendations from the experts were documented and earlier versions of the app were modified accordingly.

4.2 User Evaluation

User evaluation was conducted to determine users' perception on the usability aspect of the BMI Percentile Monitor app. The evaluation was conducted amongst 30 parents (users) who have been selected using the convenient sampling technique. The instrument used in this evaluation was adapted from previous studies and covers five dimensions which include: Usefulness, Ease of Use, Hedonic Motivation, Satisfaction and Outcome/Future Use. Usefulness constructs the level that a person believes about using a specific application would raise up the user's performance level (Davis, 1989; Zins et al, 2004). Ease of Use is the degree of easiness for a particular application by being free of heavy effort (Zins et al, 2004; Venkatesh et al, 2012). Hedonic Motivation represents the way that can be followed to motivate the users to use a specific application and how this application can influence on results (Venkatesh et al, 2012). Satisfaction measures the level of satisfaction of the user with the whole application and contents (Kicken and Stoyanov, 2008). Finally, Outcome/Future Use represents the degree a person is expecting to use this application (Davis, 1989; Zins et al, 2004). A 5-point Likert scale anchored by "Strongly Disagree" (1) and Strongly Agree (5) was used (Likert, 1932).

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5. RESULTS

Descriptive statistics, reliability analysis and t-test were used in this study. SPSS version 18 for Windows 8 was used to analyze the data. Results from the reliability, descriptive and t-test analyses are discussed in the following sections.

5.1 Demographic Data

The parents consist of 16 male (53.3%) and 14 female (46.7%) parents. In terms of education background, 17 (56.7%) of them have master and 13 (43.3%) have PhD. In terms of age, 3.3% of the parents are between 21-25 years, 33.3% are between 26-30 years, 33.3% are between 31-36 years, 13.3% are between 36-40 years and 16.7% are over 40 years.

5.2 Reliability of Measurements

Internal consistency of questionnaires' reliability can be measured in a number of ways. The most popular one is the use of Cronbach Alpha which can be calculated by using SPSS to determine the items reliability that involved in the scale. Cronbach Alpha is usually expressed on a numerical scale from 0 which represents the lower reliability to 1 which forms the greater reliability in the internal reliability criterion (Pallant, 2010). Ultimately, Cronbach alpha value is classified as follows; above 0.6 questionable, above 0.7 acceptable, above 0.8 good, above 0.9 excellent, and above 0.5 poor. Table 1 presents the Cronbach Alpha value for all the dimensions (George and Mallery, 2003). The Cronbach alpha for Usefulness is 0.885, Ease of Use is 0.826, Hedonic Motivation is 0.714, Outcome/Future Use is 0.826, and Satisfaction is 0.827. Since the Cronbach alpha values for all the dimensions are greater than 0.7, all of them satisfy the internal reliability criterion (Nunnally, 1978).

Table-1. Cronbach Alpha Values for All Dimensions.

Dimension	Number of items	Cronbach Alpha
Usefulness	6	0.885
Ease Of Use	5	0.826
Hedonic Motivation	3	0.714
Future Use	4	0.828
Satisfaction	3	0.827

5.3 Descriptive Statistics

The descriptive statistics for all the dimensions and items are presented in Table 2. Items with means more than 4.0 are bolded which indicate that most of the users agreed on these items and only one item has a mean of 3.90 (*).

Table-2. Descriptive Statistics for All Items.

Item	Mean	Std. Deviation
Perceived usefulness		
Using the BMI percentile monitor would enable me to accomplish tasks more quickly in knowing my child's BMI status	**4.47**	0.571
Using the BMI percentile monitor would make it easier for me to monitor my child's BMI status	**4.47**	0.571
I find the BMI percentile monitor useful in determining my child's BMI status	**4.50**	0.572
BMI percentile monitor is suitable for both experienced and inexperienced parents in determining the child's BMI status	**4.10**	0.759
I find the BMI percentile monitor adequate as needed	**4.13**	0.776
Overall, i find that the BMI percentile monitor is useful	**4.37**	0.556
Perceived ease of use		
Learning the BMI percentile monitor is easy for me	**4.27**	0.640
My interaction with the BMI percentile monitor is clear and understandable.	**4.23**	0.568

I find the BMI percentile monitor is flexible to use.	**4.23**	0.568
I find the BMI percentile monitor is satisfying to use	**4.20**	0.714
Overall, I find the BMI percentile monitor easy to use	**4.20**	0.714
Perceived hedonic motivation		
I find that using the BMI percentile monitor on my mobile device was fun and appealing to me.	**4.20**	0.551
Monitoring the child's BMI status by using the BMI percentile monitor is enjoyable.	**4.10**	0.548
I would recommend other parents to also use the BMI percentile monitor	**4.37**	0.490
Perceived outcome / future use		
I could effectively complete my tasks using the BMI percentile monitor.	**4.10**	0.662
I was able to efficiently complete my tasks using the BMI percentile monitor.	3.90*	0.803
From my current experience with using the BMI percentile monitor, I think I would use it regularly.	**4.00**	0.743
I would recommend to others the BMI percentile monitor.	**4.20**	0.664
Perceived satisfaction		
I felt comfortable using the BMI percentile monitor.	**4.23**	0.626
I enjoyed using the BMI percentile monitor.	**4.07**	0.740
Overall, I am satisfied with BMI percentile monitor.	**4.30**	0.535

5.4 Independent-samples T-Test

An independent-samples t-test was conducted to compare mean scores for Male and Female parents for all the dimensions in order to signify the differences statistically. The results indicated that there is no significant difference between the two groups for all the dimensions since all the significant values are greater than 0.05 (George and Mallery, 2003) as shown in Table 3.

Table-3. Group Statistics

Dimensions	Gender	Std. Deviation	Sig.
Usefulness	Male	0.50918	0.802
	Female	0.51311	
Ease Of Use	Male	0.58066	0.085
	Female	0.39586	
Hedonic Motivation	Male	0.48496	0.199
	Female	0.35635	
Outcome / Future Use	Male	0.60467	0.622
	Female	0.58012	
Satisfaction	Male	0.56928	0.729
	Female	0.55028	

6. DISCUSSION AND CONCLUSION

This paper describes the development and evaluation of the BMI Percentile Monitor app. This app provides parents with many options which include; data entry, data monitoring, data update, saving and deleting data for the purpose of monitoring their children's BMI status so as to allow parents to take appropriate early intervention in reducing the problems associated to obesity. Even though there are various mobile apps that are available in the market for the purpose of calculating the BMI, apps specifically for monitoring the children's BMI status by parents are still limited. Most mobile apps do not calculate and display the BMI charts over time. In addition, the BMI values of multiple entries could not be saved over time in the database to produce on-demand charts. Moreover, advises are not provided to help the parents to deal with their child obesity problems.

Questionnaires were used to record the perceptions of parents towards the use of the BMI Percentile Monitor app. The results revealed that the parents appreciated the BMI Percentile Monitor app in monitoring their children's BMI status and its various built-in features. The descriptive statistics indicated that the parents agreed in terms of Usefulness, Ease of Use, Hedonic Motivation, Satisfaction and Outcome/Future Use of the app. Besides that, the experts found that the app complies with all required standards both in terms of the interface design and also the medical information contents.

Overall, this study highlights the importance of parents' involvements as the most influential remedy to child obesity problems. Thus, our effort in developing the BMI Percentile Monitor app coincides with the need to involve parents to ensure the success in reducing the child obesity problems. It is hoped that the findings of this research will encourage parents to use the BMI Percentile Monitor app not just for monitoring their children's BMI status but also to eventually be a more responsible parents.

This research focuses on the perception of parents towards the use of the BMI Percentile Monitor app. Due to time limitations, work constraints and not enough motivation or ability, some parents tend to neglect in carrying out their responsibilities in monitoring their children's BMI status. Further work to be considered can be a theoretical framework for investigating the important determinants in changing the parents' behavior towards the use of the app in monitoring their children's BMI status by incorporating persuasive technology into the app.

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